CLEAN VERSION OF AMENDED APPLICATION

SI01-014

OPTICAL COUPLING DEVICE

Priority Applications

[0001] This application claims the benefit of priority under 35 U.S.C. §119 of German patent Application No. P19924183.2, filed July 21, 1999, and is a national stage filing under 35 U.S.C. §371 of PCT application PCT/DE00/02396, filed July 21, 2000.

Field Of The Invention

[0002] The invention relates to an optical coupling device for injecting light between two optical waveguide end faces, it being possible to vary the geometrical position of the one optical waveguide end face, for example an optical fibre, with respect to the other optical waveguide end face, for example an optical waveguide chip, with the aid of a variable-length element which, via a holding device, carries one of the two optical waveguides and is fixed to the other optical waveguide by two holding blocks.

Background Of The Invention

[0003] An optical coupling device is known, for example, from WO 98/13718. Such coupling devices are used in optical filters according to the phased-array principle with an injection face which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Such optical filters according to the phased-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operation (WDM), since they exhibit low insertion attenuation and high crosstalk suppression. The optical filter has, as an essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region.

[0004] German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the optical waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fibre. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

[0005] In the optical coupling device cited in the Field Of The Invention, the holding blocks are fixed to the chip, and the optical waveguide fibres are held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fibre, even though a certain degree of guidance is provided.

Summary Of The Invention

[0006] The invention is, therefore, directed to ensuring improved guidance of the variable-length element parallel to its main extension direction (longitudinal axis of the element) and to avoid deadjustment during operation.

[0007] In the optical coupling device of the invention, the variable-length element or the holding element is held by a spring element, which is supported directly or indirectly on at least one of the holding blocks and permits movements of the variable-length element or the holding element in the longitudinal direction of the variable-length element in which the variable-length element extends or shortens, and suppresses movement of the variable-length element perpendicular to the longitudinal direction of the variable-length element, the spring element being held close to the fixing of the holding blocks on the other optical waveguide. In the invention, one optical waveguide, that is to say the optical fibre, is held as close to the fixing as possible by the spring element. The variable-length element, which is necessarily fixed, further removed, to the other (second) optical waveguide, that is to say to the chip, presses against the holding element for the fibre, in order to permit the relative movement of the fibre with respect to the chip. The spring element is configured in such a way that a residual movement perpendicular to the plane is suppressed as completely as possible. This means that the movement of the fibre relative to the chip takes place very exactly parallel to the chip face, and deadjustment perpendicular to the latter virtually does not occur.

[0008] In the invention, it is further advantageous that the holding block can be adhesively bonded to the second optical waveguide (optical waveguide chip, also called a planar waveguide) very close to the fibre, which avoids long levers. As a result, undesired movements in the directions perpendicular to the desired extension of the variable-length element are reduced considerably.

[0009] One advantageous configuration of the coupling device according to the invention is that the variable-length element, the holding element and the spring element are arranged between the two holding blocks, and in that the holding element is formed in one piece with the variable-length element, and the spring element is formed separately therefrom. In this case, it is advantageous that the material of the spring element can be selected without having to take into account the requirements which are placed on the material of the variable-length element.

[0010] A further advantageous configuration of the coupling device according to the invention is that the variable-length element, the holding element and the spring element are

arranged between the two holding blocks, and in that the holding element, the variable-length element and the spring element are formed in one piece. This configuration has production advantages and also has advantages in relation to the operational reliability and the lifetime of the arrangement.

[0011] A further advantageous configuration of the coupling device according to the invention is that the variable-length element, the holding element and the spring element are arranged between the two holding blocks, and in that the holding element and the spring element are formed in one piece and the variable-length element is formed separately therefrom. Here, too, the holding elements and the spring element can be produced without any regard to the material of the variable-length element.

[0012] A further advantageous configuration of the coupling device according to the invention is that the spring element is formed by slots in the variable-length element or the holding element, the said slots lying in a plane parallel to the end faces and perpendicular to the longitudinal direction of the variable-length element. These slots can be applied particularly advantageously when the variable-length element, the holding element and the spring element or, alternatively, at least the holding element and the spring element, are formed in one piece with one another. In addition, the direction of the slots is advantageous in as much as if the slots are rotated, for example through 90°, the stability in the critical direction perpendicular to the plane of the chip is no longer adequately guaranteed.

[0013] A further advantageous configuration of the coupling device according to the invention is that an even number of slots is provided. As a result, the tendency to tilt can be minimized.

[0014] A further advantageous configuration of the device according to the invention is that the spring element is formed by holes in the variable-length element or the holding element, the said holes lying in a plane parallel to the end faces and perpendicular to the longitudinal direction of the variable-length element. Holes of this type can easily be produced by machine, the spring constant of the spring element being adjustable via the size of the holes.

[0015] A further advantageous configuration of the coupling device according to the invention is that the spring element consists of bent spring sheet, whose spring sections lie in planes which are perpendicular to a plane which is perpendicular to the chip face and perpendicular to the longitudinal direction of the variable-length element. This orientation of the spring sections is advantageous with regard to suppressing the oscillatory movements perpendicular to the longitudinal direction of the variable-length element.

[0016] A further advantageous configuration of the coupling device according to the invention is characterized in that the length of the variable-length element is selected such that the spring element is under pre-stress in the initial position of the variable-length element. This ensures that the holding device, if it is formed separately from the variable-length element, follows the variable-length element when the latter contracts.

[0017] A further advantageous configuration of the device according to the invention is that the two holding blocks are connected to each other by a clip, the arrangement, comprising the two holding blocks, the variable-length element, the holding element and the spring element, being imparted greater stability.

[0018] A further advantageous configuration of the coupling device according to the invention is that the two holding blocks are connected to each other by a frame, a clip being provided at the top and bottom in each case between the two holding blocks, and the clips being produced from one piece with the holding blocks, so that they can be adhesively bonded to the chip together with the said holding blocks.

[0019] A further advantageous configuration of the coupling device according to the invention is that the spring element is located between the clip and the frame and the holding element which is located between the two holding blocks, and in that the variable-length element is mounted in one of the holding blocks and is connected to the holding element device. In this case, the bonding or fixing points of the entire arrangement, namely the adhesive bonding of the holding blocks to the chip, are located in the immediate vicinity of the injection point, and the relative movement between the two optical waveguides is carried out by means of the variable-length element, which is mounted in one of the holding blocks and presses against the holding element.

[0020] A further advantageous configuration of the coupling device according to the invention is that an opposing spring is provided between the holding element and the other holding block and, in the initial position of the variable element, is under pre-stress, by which means, in the event of contraction of the variable-length element, the corresponding return movement is increased.

[0021] A further advantageous configuration of the coupling device according to the invention is that the variable-length element is guided in one of the holding blocks and is operatively connected to a wavelength compensating screw, with which the position of the variable-length element can be adjusted in the longitudinal direction of the latter, as a result

of which the zero position of the wavelength can advantageously still be adjusted, even after the coupling device has been bonded adhesively to the optical waveguide chip, which further increases the production reliability.

[0022] Finally, a further advantageous configuration of the coupling device according to the invention is that the holding element has a ferrule, in which the optical waveguide or the optical fibre is fixed. Although it would also be possible to fix the fibre to the spring element without a ferrule, for example by means of adhesive bonding in a V groove, the use of a ferrule is preferred because of the accuracy of the installation and the avoidance of ageing phenomena on the adhesive for the adhesive bonding of the fibre in the V groove.

Brief Description Of The Drawings

[0023] Exemplary embodiments of the invention will be described by using the appended drawings, in which:

[0024] Fig. 1 shows a side view of a coupling device according to a first exemplary embodiment of the invention;

[0025] Fig. 2 shows a side view of a second exemplary embodiment of the coupling device according to the invention;

[0026] Fig. 3 shows a side view of a third exemplary embodiment of the coupling device according to the invention;

[0027] Fig. 4 shows a side view of a fourth exemplary embodiment of the coupling device according to the invention;

[0028] Fig. 5 shows a plan view of a fifth exemplary embodiment of the coupling device according to the invention;

[0029] Fig. 6 shows a plan view of the end of the fifth exemplary embodiment of the coupling device according to the invention;

[0030] Fig. 7 shows a plan view of a sixth exemplary embodiment of the coupling device according to the invention;

[0031] Fig. 8 shows a perspective side view of a seventh exemplary embodiment of the coupling device according to the invention; and

[0032] Fig. 9shows a perspective side view of the other side of the seventh exemplary embodiment of the coupling device according to the invention.

Detailed Description Of The Invention

[0033] Figure 1 shows a side view of a coupling device according to a first exemplary embodiment of the invention, in which two holding blocks 4, 6 (for example glass or glass ceramic) are fixed or adhesively bonded on an optical waveguide chip 2. One of the holding blocks 4 bears the variable-length element 8, which is produced from aluminium, for example, and on which a fibre 10 with a ferrule 12 is fixed. The variable-length element 8 is supported on the other holding block 6 via a spring element 14, which is formed by slots 16.

[0034] The spring element 14 is formed by slots 16 which are formed in the variable-length element 8 and which extend in a plane perpendicular to the longitudinal direction of the variable-length element 8, the open edges in this case being perpendicular to the plane of the chip. An even number of slots 16, namely four slots, is provided. In this exemplary embodiment, the variable-length element 8 is formed in one piece with the spring element 14, and an end section of the variable-length element 8 forms the holding element for the ferrule 12.

[0035] Figure 2 shows a side view of a coupling device according to a second exemplary embodiment of the invention, in which two holding blocks 24, 26 are fixed or adhesively bonded on an optical waveguide chip 22. One of the holding blocks 24 bears the variable-length element 28, on which a fibre 30 with a ferrule 32 is fixed. The variable-length element 28 is supported on the other holding block 26 via a spring element 34, which is formed by holes 36.

[0036] As in the preceding exemplary embodiment, the hole 36 is also located in a plane parallel to the end faces of the optical waveguides and perpendicular to the longitudinal direction of the variable-length element. The variable-length element 28 and the spring element 34 are formed in one piece, and the ferrule 32 is anchored directly in the variable-length element, its corresponding section serving as a holding element.

[0037] Figure 3 shows a side view of a coupling device according to a third exemplary embodiment of the invention, in which two holding blocks 44, 46 are fixed or adhesively bonded on an optical waveguide chip 42. One of the holding blocks 44 bears the variable-length element 48, on which a fibre 50 with a ferrule 52 is fixed. The

variable-length element 48 is supported on the other holding block 46 via a spring element 54 which consists of spring sheet and is formed by spring sections 56.

[0038] The spring sections 56 of the spring element 54 lie in planes which are perpendicular to the chip face and perpendicular to the longitudinal direction of the variable-length element 48. In this exemplary embodiment, the spring element 54 is formed separately from the variable-length element 48.

[0039] Figure 4 shows a side view of a coupling device according to a fourth exemplary embodiment of the invention, in which two holding blocks 64, 66 are fixed or adhesively bonded on an optical waveguide chip 62. One of the holding blocks 64 bears the variable-length element 68 which is supported on the other holding block 66 via the holding device 78 and a spring element 74. The holding device 78, in which a fibre 70 with a ferrule 72 is fixed, is connected to the spring element 74. In this exemplary embodiment, the three components, namely the variable-length element 68, the holding element 78 and the spring element 74, are each formed as individual components.

[0040] Figure 5 shows a plan view of a fifth exemplary embodiment of the coupling device according to the invention, in which two holding blocks 84, 86 are provided, of which one holding block 84 bears a variable-length element 88 which has a hole 90 for a ferrule as a holder for an optical fibre and is supported via a spring element 92 on the other holding block 86. The two holding blocks 84, 86 are connected to each other via a clip 94, as shown in plan view in Figure 5 and in side view in Figure 6. The coupling device is coupled to an optical waveguide chip 82, as illustrated in Figure 6.

[0041] Figure 7 shows a plan view of a sixth exemplary embodiment of the coupling device according to the invention, which has two holding blocks 104, 106, of which one holding block 104 bears a variable-length element 108 which has a hole 110 for a ferrule with the optical fibre and is supported via a spring element 112 on the other holding block 106. The two holding blocks 104, 106 are connected to each other via two clips 114, 116, so that a frame is formed, which ensures that the coupling device is stabilized overall. The clips in this exemplary embodiment and in the preceding exemplary embodiment can be produced in one piece or can be adhesively bonded to each other.

[0042] Figure 8 shows a perspective side view of a seventh exemplary embodiment of the coupling device according to the invention, while Figure 9 illustrates a perspective side view of the same exemplary embodiment from the other side. In this exemplary embodiment, two holding blocks are fixed or adhesively bonded on an optical waveguide chip 122. One of the

holding blocks 124 bears the variable-length element 128 in the form of a bolt, which is guided in a guide bushing 130 on the holding block 124 and in a hole 132 in the holding block 124. The guide bushing 130 and the holding block 124 are formed in one piece. A hole 134 in the bushing 130, which accommodates the outer end of the variable-length element 128, is provided with a thread 136, into which a screw 138 is screwed, using which the position of the variable-length element 128 can be varied in the longitudinal direction of the latter. The screw 138 can be provided in one piece or separately from the variable-length element 128.

[0043] The two holding blocks 124, 126 are connected to each other via a clip 140, which has a spring element 142 with a holding element [device] 146 for a ferrule 148 for holding a fibre 150. In addition, an opposing spring 152 can be arranged between the holding element [device 146 and the other holding block 126, and ensures an appropriate return movement when the variable-length element 128 shortens. The opposing spring 152 is not absolutely necessary, since the holding element [device] 146 can already be prestressed via the spring element 142. If the variable-length element 128 extends, it presses against the holding element [device] 146 and moves the fibre 150 to the right (viewing direction as in Figure 8), the spring element 142 giving way appropriately. Finally, two holes 154, 156 are also provided in the clip 140, in order to reduce the overall weight of the coupling device.

Abstract Of The Invention

An optical coupling device for injecting light between two optical waveguide end faces, it being possible to vary the geometrical position of one optical waveguide end face with respect to the other optical waveguide end face with the aid of a variable-length element. The element bears one of the two optical waveguides, and is fixed to the other optical waveguide via holding blocks. The variable-length element or the holding device is held by a spring element, which is supported directly or indirectly on at least one of the holding blocks and permits movement of the variable-length element or the holding element in the longitudinal direction of the variable-length element in which the variable-length element extends or shortens, and suppresses movement of the variable-length element perpendicular to the longitudinal direction of the variable-length element, the fibre being held on the other optical waveguide by the spring element close to the fixing of the holding blocks.

Patent claims

1. Optical coupling device for injecting light between two optical waveguide end faces, the geometric position of one optical waveguide end face, for example of an optical fibre, being capable of being varied with respect to the other optical waveguide end face, for example of an optical waveguide chip, with the aid of a variable-length element, which carries one of the two optical waveguides via a holding device and is fixed to the other optical waveguide by means of a holding block, characterized in that the variable-length element (P28, 48, 68, 88, 108, 128) or the holding device is held by a spring element, which is supported directly or indirectly on at least one of the holding blocks (4, 6; 24, 26; 44, 46; 64, 66; 84, 86; 104, 106; 124, 126) and permits movements of the variable-length element or of the holding device in the longitudinal direction of the variable-length element, in which the variable-length element expands or shortens, and suppresses movement of the variable-length element perpendicular to the longitudinal direction of the variable-length element, the spring element being held close to the fixing of the holding blocks to the other optical waveguide.

2. Device according to Claim 1, characterized in that the variable-length element (48), the holding device and the spring element (56) are arranged between the two holding blocks (44, 46), and in that the holding device is formed in one piece with the variable-length element and the spring element is formed separately therefrom.

3. Device according to Claim 1, characterized in that the variable-length element (8, 26), the holding device and the spring element are arranged between

the two holding blocks (4, 6; 24, 26), and in that the holding device, the variable-length element and the spring element are formed in one piece.

4. Device according to Claim 1, characterized in that the variable-length element (68), the holding device (78) and the spring element (74) are arranged between the two holding blocks (64, 66), and in that the holding device and the spring element are formed in one piece and the variable-length element is formed separately therefrom.

5. Device according to Claim 2, 3 or 4, characterized in that the spring element (14) is formed by slots (16) in the variable-length element (8) or the holding device, the said slots lying in a plane perpendicular to the longitudinal direction of the variable-length element, the open edges lying perpendicular to the chip plane.

6. Device according to Claim 5, characterized in that an even number of slots (16) is provided.

7. Device according to Claim 2, 3 or 4, characterized in that the spring element (34) is formed by holes (38) in the variable-length element (28) or the holding device, the said holes lying in a plane parallel to the end faces of the optical waveguides and lying perpendicular to the longitudinal direction of the variable-length element.

8. Device according to Claim 1, characterized in that the spring element (54; 74) consists of bent spring sheet, whose spring sections lie in planes which are perpendicular to the longitudinal direction of the variable-length element (48; 68),

the bent edges lying perpendicular to the chip plane.

9. Device according to Claim 6, characterized in that the length of the variable-length element is selected such that the spring element is under prestress in the initial position of the variable-length element.

10. Device according to one of the preceding claims, characterized in that the two holding blocks (84, 86) are connected to each other by a clip (94), the arrangement comprising the two holding blocks, the variable-length element, the holding device and the spring element being given greater stability.

11. Device according to Claim 1, characterized in that the two holding blocks are connected to each other by a frame, a clip being provided at the top and bottom in each case between the two holding blocks, and the clips being produced from one piece with the holding blocks.

12. Device according to Claim 10, characterized in that the spring element (142) is located between the clip (140) and the holding device (146) which is located between the two holding blocks (124, 126), and in that the variable-length element (128) is mounted in one of the holding blocks (124) and is connected to the holding device (146).

13. Device according to Claim 12, characterized in that between the holding device (146) and the other holding block (126) an opposing spring (152) is provided which, in the initial position of the variable-length element, is under prestress, as a result of which, in the event of contraction of

the variable-length element, the corresponding return movement is increased.

14. Device according to Claim 12, characterized in that the variable-length element (128) is guided in one of the holding blocks (124) and is operatively connected to a wavelength compensating screw (138), with which the position of the variable-length element (128) can be adjusted in its longitudinal direction.

15. Device according to Claim 1, characterized in that the holding device has a ferrule (for example 12), in which the optical waveguide (10) or the optical fibre is fixed.

Abstract

Optical coupling device

An optical coupling device for injecting light between two optical waveguide end faces, it being possible to vary the geometrical position of one optical waveguide end face with respect to the other optical waveguide end face with the aid of a variable-length element. The element bears one of the two optical waveguides, and is fixed to the other optical waveguide via holding blocks. The variable-length element or the holding device is held by a spring element, which is supported directly or indirectly on at least one of the holding blocks and permits movement of the variable-length element or the holding device in the longitudinal direction of the variable-length element in which the variable-length element extends or shortens, and suppresses movement of the variable-length element perpendicular to the longitudinal direction of the variable-length element, the fibre being held on the other optical waveguide by the spring element close to the fixing of the holding blocks.

Figure 1

Description

Optical coupling device

The invention relates to an optical coupling device for injecting light between two optical waveguide end faces, it being possible to vary the geometrical position of the one optical waveguide end face, for example an optical fibre, with respect to the other optical waveguide end face, for example an optical waveguide chip, with the aid of a variable-length element which, via a holding device, carries one of the two optical waveguides and is fixed to the other optical waveguide by two holding blocks.

An optical coupling device is known, for example, from WO 98/13718. Such coupling devices are used in optical filters according to the phased-array principle with an injection face which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Such optical filters according to the phased-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operation (WDM), since they exhibit low insertion attenuation and high crosstalk suppression. The optical filter has, as an essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region.

German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the optical waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fibre. Since it is therefore desirable for the optical waveguides to be

shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

In the optical coupling device cited in the introduction, the holding blocks are fixed to the chip, and the optical waveguide fibres are held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fibre, even though a certain degree of guidance is provided.

The invention is therefore based on the object of ensuring improved guidance of the variable-length element parallel to its main extension direction (longitudinal axis of the element) and to avoid deadjustment during operation.

In order to achieve this object, the optical coupling device mentioned in the introduction is characterized in that the variable-length element or the holding device is held by a spring element, which is supported directly or indirectly on at least one of the holding blocks and permits movements of the variable-length element or the holding device in the longitudinal direction of the variable-length element in which the variable-length element extends or shortens, and suppresses movement of the variable-length element perpendicular to the longitudinal direction of the variable-length element, the spring element being held close to the fixing of the holding blocks on the other optical waveguide. In the invention, one optical waveguide, that is to say the fibre, is held as close to the fixing as possible by the spring element. The variable-length element, which is necessarily fixed, further removed, to the other optical waveguide, that is to say to the chip, presses against the holding device for the fibre, in order to permit the relative movement of the fibre with respect to the chip. The

spring element is configured in such a way that a residual movement perpendicular to the plane is suppressed as completely as possible. This means that the movement of the fibre relative to the chip takes place very exactly parallel to the chip face, and deadjustment perpendicular to the latter virtually does not occur.

In the invention, it is further advantageous that the holding block can be adhesively bonded to the second optical waveguide (optical waveguide chip) very close to the fibre, which avoids long levers. As a result, undesired movements in the directions perpendicular to the desired extension of the variable-length element are reduced considerably.

One advantageous configuration of the device according to the invention is characterized in that the variable-length element, the holding device and the spring element are arranged between the two holding blocks, and in that the holding device is formed in one piece with the variable-length element, and the spring element is formed separately therefrom. In this case, it is advantageous that the material of the spring element can be selected without having to take into account the requirements which are placed on the material of the variable-length element.

A further advantageous configuration of the device according to the invention is characterized in that the variable-length element, the holding device and the spring element are arranged between the two holding blocks, and in that the holding device, the variable-length element and the spring element are formed in one piece. This configuration has production advantages and also has advantages in relation to the operational reliability and the lifetime of the arrangement.

A further advantageous configuration of the device according to the invention is characterized in that the variable-length element, the holding device and the spring element are arranged between the two holding blocks, and in that the holding device and the spring element are formed in one piece and the variable-length element is formed separately therefrom. Here, too, the holding devices and the spring element can be produced without any regard to the material of the variable-length element.

A further advantageous configuration of the device according to the invention is characterized in that the spring element is formed by slots in the variable-length element or the holding device, the said slots lying in a plane parallel to the end faces and perpendicular to the longitudinal direction of the variable-length element. These slots can be applied particularly advantageously when the variable-length element, the holding device and the spring element or, alternatively, at least the holding device and the spring element, are formed in one piece with one another. In addition, the direction of the slots is advantageous in as much as if the slots are rotated, for example through 90°, the stability in the critical direction perpendicular to the plane of the chip is no longer adequately guaranteed.

A further advantageous configuration of the device according to the invention is characterized in that an even number of slots is provided. As a result, the tendency to tilt can be minimized.

A further advantageous configuration of the device according to the invention is characterized in that the spring element is formed by holes in the variable-length element or the holding device, the said holes lying in a plane parallel to the end faces and perpendicular to the longitudinal direction of the

variable-length element. Holes of this type can easily be produced by machine, the spring constant of the spring element being adjustable via the size of the holes.

A further advantageous configuration of the device according to the invention is characterized in that the spring element consists of bent spring sheet, whose spring sections lie in planes which are perpendicular to a plane which is perpendicular to the chip face and perpendicular to the longitudinal direction of the variable-length element. This orientation of the spring sections is advantageous with regard to suppressing the oscillatory movements perpendicular to the longitudinal direction of the variable-length element.

A further advantageous configuration of the device according to the invention is characterized in that the length of the variable-length element is selected such that the spring element is under prestress in the initial position of the variable-length element. This ensures that the holding device, if it is formed separately from the variable-length element, follows the variable-length element when the latter contracts.

A further advantageous configuration of the device according to the invention is characterized in that the two holding blocks are connected to each other by a clip, the arrangement, comprising the two holding blocks, the variable-length element, the holding device and the spring element, being imparted greater stability.

A further advantageous configuration of the device according to the invention is characterized in that the two holding blocks are connected to each other by a frame, a clip being provided at the top and bottom in each case between the two holding blocks, and the clips being produced from one piece with the holding blocks,

so that they can be adhesively bonded to the chip together with the said holding blocks.

A further advantageous configuration of the device according to the invention is characterized in that the spring element is located between the clip and the frame and the holding device which is located between the two holding blocks, and in that the variable-length element is mounted in one of the holding blocks and is connected to the holding device. In this case, the bonding or fixing points of the entire arrangement, namely the adhesive bonding of the holding blocks to the chip, are located in the immediate vicinity of the injection point, and the relative movement between the two optical waveguides is carried out by means of the variable-length element, which is mounted in one of the holding blocks and presses against the holding device.

A further advantageous configuration of the device according to the invention is characterized in that an opposing spring is provided between the holding device and the other holding block and, in the initial position of the variable element, is under prestress, by which means, in the event of contraction of the variable-length element, the corresponding return movement is increased.

A further advantageous configuration of the device according to the invention is characterized in that the variable-length element is guided in one of the holding blocks and is operatively connected to a wavelength compensating screw, with which the position of the variable-length element can be adjusted in the longitudinal direction of the latter, as a result of which the zero position of the wavelength can advantageously still be adjusted, even after the coupling device has been bonded adhesively to the optical waveguide chip, which further increases the production reliability.

Finally, a further advantageous configuration of the device according to the invention is characterized in that the holding device has a ferrule, in which the optical waveguide or the optical fibre is fixed. Although it would also be possible to fix the fibre to the spring element without a ferrule, for example by means of adhesive bonding in a V groove, the use of a ferrule is preferred because of the accuracy of the installation and the avoidance of ageing phenomena on the adhesive for the adhesive bonding of the fibre in the V groove.

Exemplary embodiments of the invention will be described by using the appended drawings, in which:

Fig. 1 shows a side view of a coupling device according to a first exemplary embodiment of the invention;

Fig. 2 shows a side view of a second exemplary embodiment of the coupling device according to the invention;

Fig. 3 shows a side view of a third exemplary embodiment of the coupling device according to the invention;

Fig. 4 shows a side view of a fourth exemplary embodiment of the coupling device according to the invention;

Fig. 5 shows a plan view of a fifth exemplary embodiment of the coupling device according to the invention;

Fig. 6 shows a plan view of the end of the fifth exemplary embodiment of the coupling device according to the invention;

Fig. 7 shows a plan view of a sixth exemplary embodiment of the coupling device according to the invention;

Fig. 8 shows a perspective side view of a seventh exemplary embodiment of the coupling device according to the invention; and

Fig. 9 shows a perspective side view of the other side of the seventh exemplary embodiment of the coupling device according to the invention.

Figure 1 shows a side view of a coupling device according to a first exemplary embodiment of the invention, in which two holding blocks 4, 6 (for example glass or glass ceramic) are fixed or adhesively bonded on an optical waveguide chip 2. One of the holding blocks 4 bears the variable-length element 8, which is produced from aluminium, for example, and on which a fibre 10 with a ferrule 12 is fixed. The variable-length element 8 is supported on the other holding block 6 via a spring element 14, which is formed by slots 16.

The spring element 14 is formed by slots 16 which are formed in the variable-length element 8 and which extend in a plane perpendicular to the longitudinal direction of the variable-length element 8, the open edges in this case being perpendicular to the plane of the chip. An even number of slots 16, namely four slots, is provided. In this exemplary embodiment, the variable-length element 8 is formed in one piece with the spring element 14, and an end section of the variable-length element 8 forms the holding device for the ferrule 12.

Figure 2 shows a side view of a coupling device according to a second exemplary embodiment of the

invention, in which two holding blocks 24, 26 are fixed or adhesively bonded on an optical waveguide chip 22. One of the holding blocks 24 bears the variable-length element 28, on which a fibre 30 with a ferrule 32 is fixed. The variable-length element 28 is supported on the other holding block 26 via a spring element 34, which is formed by holes 36.

As in the preceding exemplary embodiment, the hole 36 is also located in a plane parallel to the end faces of the optical waveguides and perpendicular to the longitudinal direction of the variable-length element. The variable-length element 28 and the spring element 34 are formed in one piece, and the ferrule 32 is anchored directly in the variable-length element, its corresponding section serving as a holding device.

Figure 3 shows a side view of a coupling device according to a third exemplary embodiment of the invention, in which two holding blocks 44, 46 are fixed or adhesively bonded on an optical waveguide chip 42. One of the holding blocks 44 bears the variable-length element 48, on which a fibre 50 with a ferrule 52 is fixed. The variable-length element 48 is supported on the other holding block 46 via a spring element 54 which consists of spring sheet and is formed by spring sections 56.

The spring sections 56 of the spring element 54 lie in planes which are perpendicular to the chip face and perpendicular to the longitudinal direction of the variable-length element 48. In this exemplary embodiment, the spring element 54 is formed separately from the variable-length element 48.

Figure 4 shows a side view of a coupling device according to a fourth exemplary embodiment of the invention, in which two holding blocks 64, 66 are fixed or adhesively bonded on an optical waveguide chip 62.

One of the holding blocks 64 bears the variable-length element 68 which is supported on the other holding block 66 via the holding device 78 and a spring element 74. The holding device 78, in which a fibre 70 with a ferrule 72 is fixed, is connected to the spring element 74. In this exemplary embodiment, the three components, namely the variable-length element 68, the holding device 78 and the spring element 74, are each formed as individual components.

Figure 5 shows a plan view of a fifth exemplary embodiment of the coupling device according to the invention, in which two holding blocks 84, 86 are provided, of which one holding block 84 bears a variable-length element 88 which has a hole 90 for a ferrule as a holder for an optical fibre and is supported via a spring element 92 on the other holding block 86. The two holding blocks 84, 86 are connected to each other via a clip 94, as shown in plan view in Figure 5 and in side view in Figure 6. The coupling device is coupled to an optical waveguide chip 82, as illustrated in Figure 6.

Figure 7 shows a plan view of a sixth exemplary embodiment of the coupling device according to the invention, which has two holding blocks 104, 106, of which one holding block 104 bears a variable-length element 108 which has a hole 110 for a ferrule with the optical fibre and is supported via a spring element 112 on the other holding block 106. The two holding blocks 104, 106 are connected to each other via two clips 114, 116, so that a frame is formed, which ensures that the coupling device is stabilized overall. The clips in this exemplary embodiment and in the preceding exemplary embodiment can be produced in one piece or can be adhesively bonded to each other.

Figure 8 shows a perspective side view of a seventh exemplary embodiment of the coupling device according

to the invention, while Figure 9 illustrates a perspective side view of the same exemplary embodiment from the other side. In this exemplary embodiment, two holding blocks are fixed or adhesively bonded on an optical waveguide chip 122. One of the holding blocks 124 bears the variable-length element 128 in the form of a bolt, which is guided in a guide bush 130 on the holding block 124 and in a hole 132 in the holding block 124. The guide bush 130 and the holding block 124 are formed in one piece. A hole 134 in the bush 130, which accommodates the outer end of the variable-length element 128, is provided with a thread 136, into which a screw 138 is screwed, using which the position of the variable-length element 128 can be varied in the longitudinal direction of the latter. The screw 138 can be provided in one piece or separately from the variable-length element 128.

The two holding blocks 124, 126 are connected to each other via a clip 140, which has a spring element 142 with a holding device 146 for a ferrule 148 for holding a fibre 150. In addition, an opposing spring 152 can be arranged between the holding device 146 and the other holding block 126, and ensures an appropriate return movement when the variable-length element 128 shortens. The opposing spring 152 is not absolutely necessary, since the holding device 146 can already be prestressed via the spring element 142. If the variable-length element 128 extends, it presses against the holding device 146 and moves the fibre 150 to the right (viewing direction as in Figure 8), the spring element 142 giving way appropriately. Finally, two holes 154, 156 are also provided in the clip 140, in order to reduce the overall weight of the coupling device.